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ABSTRACT

Children in primary education often encounter mathematics having picked up a general fear of mathematics from the society around them. This results in lack of confidence, avoidance of non-standard thought processes, weakness in problem solving strategies, and other negative consequences. This study offers an alternative approach: presenting mathematics as dynamic, interactive entertainment. The Mathematics Society, a student club at Izmir Institute of Technology (IZTECH), has developed a Mathematics Drama program that addresses elementary mathematics. This paper presents information on how successful this group has been in addressing the needs of the pupils attending their shows and considers possible causes of the fear of mathematics, then look at the work of the Mathematics Society and discusses its validity as a possible educational model. Finally, this paper presents and analyzes data from a survey of 500 pupils. (Author/KHR)

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AVOIDING MATHEMATICS TRAUMA: ALTERNATIVE TEACHING METHODS

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ABSTRACT

Children in primary education often encounter mathematics having picked up a general fear of mathematics from the society around them; this results in lack of confidence, avoidance of non-standard thought processes, weakness in problem solving strategies and other negative consequences. We offer an alternative approach; presenting mathematics as dynamic, interactive entertainment. The Mathematics Society, a student club at Izmir Institute of Technology (IZTECH), has developed a Mathematics Drama program addressing elementary mathematics. How successful has this group been in addressing the needs of the pupils attending their shows? This presentation will first consider possible causes of the fear of mathematics, then look at the work of the Mathematics Society and discuss its validity as a possible educational model. Finally we will present and analyze data from a survey of 500 pupils .

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1. Sources of Mathematics Anxiety

Over the doors of Plato's Academy was inscribed the motto "Let no one ignorant of geometry enter here". Was this, in accordance with a rule of the almighty gods high above on Mount Olympus, beyond the scope of ordinary humans? Was it a mental inference that only the best philosophers of the time could work on? Were there other factors? Such a forbidding perception of the subject has permeated society since those days. Over 5500 years, from Ancient Greece to the beginning of the third millennium, ordinary people have passed on this fear to their children: Mathematics is the unknown, the unfathomable. While the philosophers of the Academy confidently indulged themselves in their elitist abstract competitions, an ordinary villager, Zeno, who showed with his paradoxes that the masses could understand and participate successfully in these intellectual activities, challenged them. The public could have been informed clearly about the field of mathematics, the methods of mathematical thoughts, mathematical objects and their properties, and how these relate to nature and society. Instead, Mathematics has been conveyed as difficult, abstract, and requiring intellectual curiosity. Hence it has become generally accepted that mathematics was not for the average mind, a perception unchallenged through the generations. As a result, instead of strategies of investigation, something unattractive and awkward appeared as rules and methods developed. In general the widespread assumption is that people are either good with numbers or with words; they could not be good at both. Besides, math is "dreary, never fun".

One cause of math trauma for students is the teaching style in the mathematics classroom. Pupils complain that mathematics offers little opportunity for debate or discussion. Teachers say pupils prefer literature and social studies to mathematics since they can participate more in class and are under no pressure to find the one right answer. Teachers may create anxiety by placing too much emphasis on memorizing formulae, learning mathematics through drill and practice, applying rote-memory rules and setting out work in the traditional way rather than understanding and reasoning (Greenwood, 1984).

People fail to do their best work when scared. Math anxiety or trauma develops from uncertainty and from a lack of confidence. With this anxiety or tension, understanding and recall pathways become cluttered by emotions, resulting in an inability to think. As the teacher persists in asking questions, the learner's brain stops functioning altogether. Although mathematics aims at right answers, these can be reached through open-ended problems, mathematics being experienced as a series of discoveries to be made by the learner. Rather than mathematical methods and rules, learners need to acquire abilities to analyze, question, test and find solutions: knowledge and skills relating to the processes, which can later be applied in any situation. But who will bring about this change, and how? Which methods of instruction or approaches to learning can bring mathematics to large numbers of people, in particular within the reach and interest of a significant section of young minds? Many authors have looked at the causes of mathematics anxiety and alternative teaching techniques to aid in student understanding. (Greenwood, J., 1984; Newstead, K, 1998; Hembree, R, 1990; Hopko. D.R and Ashcraft, M.H., 1998; Tobias, S, 1978)

2. The Math Show

What pupils learn is always less than what we teach. How much they learn is determined by native ability, background and learning style – which may or may not match our teaching style. There are many different types of learners: sensing, intuitive, sequential, global, active, reflexive, inductive, deductive, visual and verbal. To maximize student learning, the factor most readily

within teacher control is his or her own teaching style. The IZTECH Math Society was founded in 1998 by the first author with a group of undergraduate mathematics, science, or engineering majors. Many of these students had suffered various forms of traditional teaching and were keen to search for better alternatives by researching mathematics, having fun with mathematics, and increasing its popularity in everyday life.

The critical age for the development of mathematics trauma is between 9 and 11 (McLead, 1993). Although trauma may deepen or change throughout schooling, generally once formed, negative attitudes and anxiety are difficult to change and may persist into adult life, with far-reaching consequences in the form of avoidance of mathematics, distress, and interference with conceptual thinking and memory processes. Possible sources of trauma, namely teacher anxiety, societal, educational or environmental factors, failure and the influence of early-school experiences of mathematics (Newstead, K. 1998), were taken into consideration as we designed a math show to relieve mathematics anxiety and mathematics trauma.

Cooperative learning is a key concept in the entire process: not only in the performances themselves but also in the preparation. Encouraging people to work with peers in small co-operative groups may have important affective consequences, including a reduction in anxiety for both Math Society members and pupils. In the preparation, questions dealing with everyday events are collected from libraries and the internet, and are set to music or prepared as stories. Within the week prior to our visit to a school, the conditions at the school, the situation of the children and parental attitudes are investigated in order to choose suitable questions. In the final rehearsal, show leaders attempt to anticipate all possible questions and reactions that may arise as well as deciding the mathematical games (can be used to reinforce mathematics skills of pupils) to be included.

Shows were generally performed for groups of 20 to 100, although in some schools between 300 and 900 pupils, teachers and parents have watched the show. The math show usually involves opportunities for social interaction, independent investigation and study, and the expression of creativity, as well as provision for different learning styles; in the first ten minutes, we brainstorm "What is mathematics?" with the young people, before "the History of Mathematics" unfolds. It has become clear to us that the pupils know nothing about the history of mathematics and have little knowledge of the background of the subject. Despite a minimum of three hours of mathematics per week during the 8 years of statutory education, pupils have insufficient knowledge of what mathematics is. History is a good vehicle for reflecting on cognitive and educational problems, for working on students' conceptions of mathematics and its teaching, and for promoting flexibility and open-mindedness in mathematics (F.Furinghetti, 2000). Thus it was decided the presentations should be given through the eyes of famous mathematicians to establish important events, the roles of significant mathematicians and key concepts, all at a level and in language suited to pupils.

Music is a key feature of the show. One member is always a musician, using either guitar or flute to draw the audience into new territory, melting away fear. The musical narrator leads the plot, introducing the different mathematicians. Each has several possible questions in their repertoire to be able to respond to the interests of the crowd. Any member of the audience who wishes to try solving a question comes up on stage to explain their reasoning. Some reach the answer, others ask for clues and others give up. However, the fundamental principle is that Math Show asks open ended questions "What if, Why, How…?", "What is the meaning of…?", "How would I use … to …?", "What is the difference between … and …?", "Why is this problem difficult for you? How can we make it easier?" Pupils have a chance to watch – on the over-head

projector, a new experience for most of the spectators. As their friends progress in their reasoning, those watching think about the logical thoughts being expressed in words, actions and pictures. It becomes apparent that more than one approach may be used to reach the answer. As pupils reflect on their own learning styles, they become more adept at discovering flaws in their thinking. The aim of the show is to move away from the true/false focus, towards exploration of the subject, individually or as a group, developing problem solving strategies and collective thinking; the focus is on process rather than on the outcome. During the 1 to 2 hour-long show, transitions between activities are lightened with 'mathemusic' (musical riddles), topological games (knots to untangle), coloring puzzles (4-color problem), etc.

The first show, performed in the autumn term of 1998, rapidly drew the attention of the usually mathematically uninterested press. The following headlines appeared in the daily newspapers: "Nightmare masters", "Mathematics warriors" "Thought provoking entertainers"; a television channel announced that thanks to our shows "Children will no longer have nightmare about mathematics". Local newspapers began to publish mathematics puzzles. Faced with excessive demands for Math Show, the Mathematics Society of IZTECH was soon forced to limit performances to one per school. The society has supported the formation of mathematics groups in a number of schools.

3. Sample and Data Collection

Between October 1998 and June 2001 over 10,000 pupils, teachers and parents at 15 schools and institutions attended Math Shows. The questionnaire was given to a sample of 500 pupils (250 from state elementary schools and 250 from private schools). They were asked 10 questions after the show.

TABLE-1

1) Which year are you in?
5th grade: 20% 6th grade: 40% 7th grade: 30% 8th grade: 5% Others : 5%.
2) What was your grade last semester?
BA-AA: 20% CC-BB : 50% DD-DC : 20% FF –FD : 10%.
3) How much interested are you in Mathematics?
Very much: 26% Fairly : 50% Not Much : 14% Not at all : 10%.
4) How much interested are your parents in Mathematics?
Very much: 44% Fairly : 30% Not much : 14%

Not at all : 12%.
5) What do you think of Math Show?
Excellent: 76% Good : 20% Not bad : 2% Poor : 2%.
6) How similar are Math Show and your class activities?
Totally different: 70% A little similar : 25% Very similar : 5%
7) Would you like your math lessons to be like Math Show?
Yes : 80% No : 5% No idea :15%.
8) What did you like in Math Show? (Each pupil was asked to choose, in order of priority, the 3 factors that most impressed them)
Math Games : 90% Music : 80% Interesting problems : 70% Math Society Members : 40% Friendly Atmosphere : 40% Group Activities : 34% Technological equipment: 20%.
9) Now, do you think that Mathematics lessons can be fun?
Yes : 90% No : 4% No idea: 6%.
10) What do you feel about Mathematics?
I like it : 20% It can be interesting and fun: 50% It is hard and frightening : 30%

Discussion of Sample and Data

Questions 5 and 7 indicate very clearly that the Math Show is popular with the students. There is a strong indication that students would prefer to have non-traditional methods employed by their teachers in their math lessons. The children were so engrossed in the show that they did not realize that time had passed. The show always generates great enthusiasm, with many requests for more mathematics. Many children who had never considered that mathematics lessons could possibly be fun had changed their minds by the end of the show. Question 9 reports that 90% of students see how mathematics lessons can be fun when offered in a non-traditional format.

Question 4 indicates that the students' perceptions of parental interest are high. These pupils are aware that their parents value success in mathematics. The students' themselves were fairly interested in mathematics, as question 3 reveals.

We had anticipated 'novel equipment' might have attracted higher ratings; however, this option had the lowest level of interest. As question 8 shows, the highest levels of interest were in mathematics games, music and interesting problems, reflecting a focus on the essence of the show.

We also asked the teachers their opinion of the show. Teachers who attended the show were impressed, though many feel they cannot teach in such a dynamic way in their regular classes. This reflects what the literature says. Most mathematics teaching is done in a traditional manner. In addition, question 6 indicates that most in-class activities are not similar to the math show.

4. Conclusion

Overall, the math show benefited the teachers, the elementary school students, and the undergraduate students participating in the show. The show enabled teachers to realize that their teaching styles did not always match the learning styles of their pupils, and that a broader more varied approach can increase pupils' attention and interest during lessons. The data supports this conclusion. Abstract mathematical concepts can be better grasped if presented using drama, music and concrete applications of the concept, thus facilitating internalization and generalization.

The pupils not only developed greater awareness of their learning styles, but also learned not to be afraid of making mistakes, and to persevere in problem solving. Furthermore they began to be able to understand what was blocking their thought processes and avoid the obstruction. They also realized that self-confidence and the ability to generate ideas towards solving a problem are more important than getting the answer. Math anxiety was reduced or eliminated with this method of teaching mathematical concepts.

The undergraduate students participating in the Math Show also gained positively from the experience. They became more effective learners and teachers, both individually and in a group. They learned to develop and utilize different teaching techniques. Key concepts of each problem were discussed and became the focus of learning. In addition, they developed independent thinking skills and better self-confidence.

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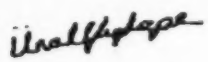

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